CLAIMS:

1. An EGR control device for an internal combustion engine provided with an EGR passage through which an exhaust passage and an intake passage of the internal combustion engine communicate with each other, and with an EGR control valve across which the EGR passage extends and which controls a flow rate of EGR gas flowing from the exhaust passage to the intake passage, comprising:

operational state quantity acquisition means that acquires an operational state quantity of the engine;

target EGR ratio determination means that determines, on the basis of the detected operational state quantity, a target value of an EGR ratio, namely, a ratio of a flow rate of EGR gas sucked by the engine to a flow rate of gas sucked by the engine, as a target EGR ratio;

target air flow rate determination means that determines, on the basis of the detected operational state quantity, a target value of a flow rate of air sucked by the engine, as a target air flow rate;

actual EGR ratio acquisition means that acquires a true EGR ratio on the basis of the detected operational state quantity, as an actual EGR ratio;

actual air flow rate acquisition means that acquires, on the basis of the detected operational state quantity, an actual flow rate of air sucked by the engine, as an actual air flow rate; and

EGR ratio control means that controls an actual EGR ratio by controlling an opening of the EGR control valve in accordance with the target EGR ratio, the target air flow rate, the actual EGR ratio, and the actual air flow rate.

2. The EGR control device according to claim 1, wherein the EGR ratio control means calculates, as a target converted EGR ratio, a value corresponding to a ratio of the target EGR ratio to the target air flow rate, calculates, as an actual converted EGR ratio, a value corresponding to a ratio of the actual EGR ratio to the actual air flow

rate, and controls an opening of the EGR control valve such that the target converted EGR ratio becomes equal to the actual converted EGR ratio.

3. The EGR control device according to claim 1, wherein the EGR ratio control means calculates, as a control target EGR ratio, a value obtained by multiplying a target converted EGR ratio determined in accordance with a ratio of the target EGR ratio to the target air flow rate by the actual air flow rate, and controls an opening of the EGR control valve such that the control target EGR ratio becomes equal to the actual EGR ratio.

4. The EGR control device according to any one of claims 1 to 3, wherein the target EGR ratio determination means determines a target EGR ratio for controlling intake-air oxygen concentration and obtaining such an intake-air oxygen concentration as will suppress generation of nitrogen oxides, calculates a critical target EGR ratio for suppressing generation of smoke or particulate matters, and determines the lower one of the target EGR ratio for controlling intake-air oxygen concentration and the critical target EGR ratio as the target EGR ratio.

5. The EGR control device according to claim 1, wherein the target EGR ratio determination means determines a target EGR ratio from a command fuel injection amount and an engine rotational speed.

6. The EGR control device according to claim 1, wherein the target air flow rate determination means determines a target air flow rate from a command fuel injection amount and an engine rotational speed.

7. The EGR control device according to claim 1, wherein the actual EGR ratio acquisition means determines an actual EGR ratio from a cylinder inflow gas flow rate and an actual air flow rate.

8. The EGR control device according to claim 1, wherein the actual air flow rate acquisition means acquires an actual air flow rate from an air flow meter.

9. The EGR control device according to claim 4, wherein the EGR ratio for controlling intake-air oxygen concentration is determined from a command fuel injection amount and an engine rotational speed.

10. The EGR control device according to claim 4, wherein the critical target EGR ratio is determined from a cylinder inflow gas amount and a smoke critical minimum air flow rate.

11. An EGR control method for an internal combustion engine provided with an EGR passage through which an exhaust passage and an intake passage of the internal combustion engine communicate with each other, and with an EGR control valve across which the EGR passage extends and which controls a flow rate of EGR gas flowing from the exhaust passage to the intake passage, comprising the steps of:

acquiring an operational state quantity of the engine;

determining, on the basis of the detected operational state quantity, a target value of an EGR ratio, namely, a ratio of a flow rate of EGR gas sucked by the engine to a flow rate of gas sucked by the engine, as a target EGR ratio;

determining, on the basis of the detected operational state quantity, a target value of a flow rate of air sucked by the engine, as a target air flow rate;

acquiring a true EGR ratio on the basis of the detected operational state quantity, as an actual EGR ratio;

acquiring, on the basis of the detected operational state quantity, an actual flow rate of air sucked by the engine, as an actual air flow rate; and

controlling an actual EGR ratio by controlling an opening of the EGR control valve in accordance with the target EGR ratio, the target air flow rate, the actual EGR ratio, and the actual air flow rate.

12. The EGR control method according to claim 11, wherein the EGR ratio control calculates, as a target converted EGR ratio, a value corresponding to a ratio of the target EGR ratio to the target air flow rate, calculates, as an actual converted EGR ratio, a value corresponding to a ratio of the actual EGR ratio to the actual air flow rate, and controls an opening of the EGR control valve such that the target converted EGR ratio becomes equal to the actual converted EGR ratio.

13. The EGR control method according to claim 11, wherein the EGR ratio control calculates, as a control target EGR ratio, a value obtained by multiplying a target converted EGR ratio determined in accordance with a ratio of the target EGR ratio to the target air flow rate by the actual air flow rate, and controls an opening of the EGR control valve such that the control target EGR ratio becomes equal to the actual EGR ratio.

14. The EGR control method according to any one of claims 11 to 13, wherein the determination of the target EGR ratio determines a target EGR ratio for controlling intake-air oxygen concentration and obtaining such an intake-air oxygen concentration as will suppress generation of nitrogen oxides, calculates a critical target EGR ratio for suppressing generation of smoke or particulate matters, and determines the lower one of the target EGR ratio for controlling intake-air oxygen concentration and the critical target EGR ratio as the target EGR ratio.

15. The EGR control method according to claim 11, wherein the determination of the target EGR ratio determines a target EGR ratio from a command fuel injection amount and an engine rotational speed.

16. The EGR control method according to claim 11, wherein the determination of the target air flow rate determines a target air flow rate from a command fuel injection amount and an engine rotational speed.

17. The EGR control method according to claim 11, wherein the acquisition of the actual EGR ratio determines an actual EGR ratio from a cylinder inflow gas flow rate and an actual air flow rate.

18. The EGR control method according to claim 11, wherein the acquisition of the actual air flow rate acquires an actual air flow rate from an air flow meter.

19. The EGR control method according to claim 14, wherein the EGR ratio for controlling intake-air oxygen concentration is determined from a command fuel injection amount and an engine rotational speed.

20. The EGR control method according to claim 14, wherein the critical target EGR ratio is determined from a cylinder inflow gas amount and a smoke critical minimum air flow rate.

21. An EGR control device for an internal combustion engine comprising:

an EGR passage through which an exhaust passage and an intake passage of the internal combustion engine communicate with each other;

an EGR control valve across which the EGR passage extends and which controls a flow rate of EGR gas flowing from the exhaust passage to the intake passage; and

an EGR controller that:

acquires an operational state quantity of the engine;

determines, on the basis of the detected operational state quantity, a target value of an EGR ratio, namely, a ratio of a flow rate of EGR gas sucked by the engine to a flow rate of gas sucked by the engine, as a target EGR ratio;

determines, on the basis of the detected operational state quantity, a target value of a flow rate of air sucked by the engine, as a target air flow rate;

acquires a true EGR ratio on the basis of the detected operational state quantity, as an actual EGR ratio;

acquires, on the basis of the detected operational state quantity, an actual flow rate of air sucked by the engine, as an actual air flow rate; and

controls an actual EGR ratio by controlling an opening of the EGR control valve in accordance with the target EGR ratio, the target air flow rate, the actual EGR ratio, and the actual air flow rate.